only bestowed upon your readers once in a fortnight, my natural impetuoueness of disposition conquers my better judgment, and compels me to send you this note at once.

ON METALLIC CONSTRUCTIONS.

MR. W. FAIRBAIRN, C.E. and F.R.S. of Manchester, has been lecturing to the Mechanics' Institution there on metallic constructions. The subject of his lecture, on Friday, in last week, related chiefly to ship building, but contained various important tables indicative of the strength of materials, which we prefer selecting, as the pith of the lecture, to any attempt to report at length what may be found in the local papers of 10th inst.

Resisting Powers of Cast-Iron.—From a number of carefully conducted experiments on cast-iron, I have selected the following results. They are the highest in the order of their powers of resistance to a transverse strain, and as in each instance the bar is reduced to exactly 1 inch square, the results may fairly be estimated as a criterion of the resisting powers of the different irons of Great Britain :—

Transverse Strength of Cast-iron Bars, 1 inch square, 4 feet 6 inches between the supports :—

Name and number of iron.	Breaking weight in lbs.	Deflection in inches.	Power to resist impact.
Pookey ...... 3 C ...	581	1·747	992
Beaufort ...... 3 H ...	517	1·599	607
" ...... 3 C ...	449	1·726	747
Mean	516	1·691	848·6
Low Moor...... 2 C ...	473	1·852	855
Butterly ...... H ...	503	1·815	890
Elsecar ...... 2 C ...	427	2·124	991
Old Park ...... 2 C ...	485	1·621	718
Mean	471	1·778	863·5
Muirkirk ...... 1 C ...	416	1·570	654
Carron ...... 3 C ...	443	1·336	583
Monkland ... 2 H ...	410	1·763	700
Gartsherrie .. 3 H ...	517	1·557	908
Mean	459	1·556	739

The letters C signify cold blast. H, hot blast.

From the above it will be perceived that the average transverse strength of eleven specimens of English, Welsh, and Scotch iron is 471 lb. on 1-inch square bars, 4 feet 6 inches between the supports. These again give a mean deflection of 1·675 inch, and a power to resist impact of 817. Similar irons will resist a tensile strain and a crushing force per square inch as follows :—

Experimental results to determine the ultimate powers of resistance to a tensile and crushing strain :—

Description of iron.	Tensile strength per square inch of section.	Height of specimen.	Crushing strength per square inch of section.	Ratio of tension to compression.
	Tons.	Inches.	Tons.	
Low Moor, No. 2...	6·901	1½	41·219	1 : 5·973
Clyde, No. 2...	7·949	1½	45·549	1 : 5·729
Blaenavon, No. 2...	7·466	1½	45·717	1 : 6·123
Brymbo, No. 2 ...	6·923	1½	34·356	1 : 4·963
Mean	7·300	1½	41·710	1 : 5·707

In addition to the irons given above, which are those in common use, Mr. Stirling's mixed or toughened iron exhibits considerably increased powers of resistance to every description of strain when compared with the unmixed irons. Mr. Stirling has patented a process for mixing a certain portion of malleable with cast-iron, and when carefully fused in the crucible the product is equal to resist a tensile strain of nearly 11 tons per square inch, and a compressive one of upwards of 60 tons, the specimens being 1½ inch long and 1 inch square. This mixture, when judiciously managed and duly proportioned, increases the strength about one-third above that of ordinary cast-iron.

Resistance of Wrought-iron Plates to a Tensile Strain.—In these experiments, which were made on five different sorts of iron, the tensile strengths in tons per square inch are as follow :—

	Torn asunder in direction of the fibre.		Torn asunder across the fibre.
	Tons.		Tons.
Yorkshire plates	25·770	...	27·490
" "	22·760	...	26·037
Derbyshire "	21·680	...	18·650
Shropshire "	22·826	...	20·000
Staffordshire "	19·563	...	21·010
Mean	22·519		23·037

Or, as 22·5 : 23, equal to about $\frac{1}{45}$ in favour of those torn across the fibre. In following up the same investigation on timber, I found, according to Professor Barlow, of Woolwich, that the cohesive strength of different kinds of hard wood were—

	lb.		lb.
Box	20,000	Beech	11,500
Ash	17,000	Oak	10,000
Teak	15,000	Pear	9,800
Fir	12,000	Mahogany	8,000

Assuming Mr. Barlow to be correct, and taking the main strength of iron plates, as given in the experiments, at 49.656 lbs. to the square inch, or say 50,000 lbs. we have this comparison between wood and iron :—

	Timber.		Ratio. Iron.		Ratio Timber representing unity.		
	lb.		lb.				
Ash.	17·000	:	50·000	......	or as 1	:	2·94
Teak	15·000	:	50·000	......	or as 1		3·33
Fir	12·000	:	50·000	......	or as 1		4·16
Beech......	11·500	:	50·000	......	or as 1		4·34
Oak......	10·000	:	50·000	......	or as 1		5·00

Hence it appears that malleable iron plates are five times stronger than oak, or, in other words, their powers of resistance to a force applied to tear them asunder is as 5 to 1; making an iron plate ½-inch thick equal to an oak plank 2½ inches thick.

The results obtained from forty-seven experiments on double and single rivetting are here recorded :—

Cohesive strength of plates: breaking weight in lbs. per square-inch.	Strength of single-rivetted joints of equal section to the plates, taken through the line of the rivets, in lbs. per square inch.	Strength of double-rivetted joints of equal section to the plates, taken through the line of rivets, in lbs. per square inch.
57·724	45·743	52·352
61·579	38·908	61·921
58·322	48·141	58·286
50·983	43·515	51·661
51·130	40·249	53·779
49·281	44·715	53·879
48·806	37·161	
47·062		
Mean 52·486	41·640	53·635

The relative strengths will, therefore, be,—for the plate, 1,000; double-rivetted joint, 1,021; single-rivetted joint, 791; which shows that the single-rivetted joints have lost one-fifth of the actual strength of the plates, whilst the double-rivetted joints have retained their resisting powers unimpaired. These are convincing proofs of the superior value of the double-rivetted joints. . . . Having established correct data as respects the strengths of materials, either singly or in combination, we shall have less difficulty in their application to the construction of vessels exposed to severe strains, such as boilers, bridges, or an iron ship.

OBSERVATIONS ON TEACHING DRAWING,

ESPECIALLY TO CHILDREN AND UNEDUCATED BEGINNERS.

WITH whatever view we educate a beginner, and however high may be his future destination, we may be assured that refined lines, exquisite forms, perfect *chiaro scuro*, and harmoniously blended colouring, are not the commencement of art, and the beginner will not profit by mocking these. The beggar's appearance is nowise improved by an array of silken tatters; nor does the child become a warrior by getting a sword of lath and a wooden gun.

If it be desirable to educate the young human being into the adult comprehensive artist, all his faculties must be exercised, and, as a general rule, together: he must not be a thing of threads and patches. However correct and beautiful these are, chance will not jumble them into a harmonious, natural whole, fitted to act (as all high art should) on the entire being of the competent observer. This union is the most difficult thing of all, even under the most favourable circumstances, and it is the highest of all; and by most who strive it is rarely attained. Does the French plan of devoting many years to the sole copying of the finest lines ever produced and the most accurate shadows in neutral colour create real artists? What they do belongs not to this world—it is lifeless, repulsive; while the delay of colour to a late period of a life previously spent on black chalk and grey paper, destroys all feeling for colour. The colouring of many of these artists is disagreeable, and frequently disgusting. If an eye for colour be not got early in life, it will probably never be attained.

So also of the higher mental faculties connected with art, especially the invention or imagination. If these be disregarded until late in life, mere imitators, mere clever machines are the usual results. No beings are so imaginative and inventive as young children, and why should their faculties be smothered in unfathomable strata of mathematical diagrams? In our zeal for the hand we must not forget the head.

Let the understanding go first, above all things, and rule the hand and eye. By inverting this order, and allowing the hand and eye to take precedence, and rule over the higher powers, good mechanical draughtsmanship may be attained, but the most valuable purposes of drawing are lost sight of.

More than one instance has been observed of children unusually slow and incorrect in imitative drawing, who have exhibited at least the average powers in exercises for the invention. Renewed exertion is likely to take the place of despondency on finding that they are not always below their fellows. Exclusive attention to single parts is apt to distort the mind by the very success attained in such partial operations. Hence many of the common mannerisms and tricks into which artists are so apt to settle down.

No one was ever a great artist who was not a great man: and yet we try to make great artists by preventing our pupils from becoming even little men. A human being is not an anatomical preparation, nor a thing of dry bones, be they bleached ever so whitely, nor a walking rule and compasses. It is a painful sight to witness youths set to copy from morning to night,—their general education neglected, and even their art-faculties of the higher kind uncared for. The true artist is made of other stuff. Universal powers are wanted for his high future calling. Like the young of every other kind, he tries his powers in every way, in mimic action certainly, but they all act, and act together rather than apart: thus, in time, all attain adult proportions. He copies, not for the sake of copying, but to show him how he may be a better original. Of himself he does what he can, and then copies to find out how he can do better; but he never gives up working for himself. He makes lines, the best he can, and bad they are: in time he does better and better, for perfect lines betoken high art. He copies lines occasionally, and mathematical figures, not for their own sake, but because he has made such general advance as to feel his imperfections and to desire to remedy them. He wishes to learn all art, and not merely a few tricks of the hand; to imitate nature with refinement and feeling, not to make a staring likeness of petty details. Hence his work is an endless variety of trials and experiments in all directions: outline, shade, colour, composition perpetually recur from beginning to end, but not as things apart; and less as things in themselves than as the sensuous exponents of thought and emotion. Above all, he will not willingly do anything that he does not understand; not through the vain belief that he has arrived at perfection, and that there is not much that is true and good and great that he will never reach; or that there is not much hard work still before him to attain even a slender portion of these; but because he is assured that if he once lose his firm footing on the earth he will be tripped up and tossed about in the ocean of distraction and error.

The admirers of the abstract method contend that bad habits must be guarded against, and none but good habits permitted and enforced from the beginning of the youngest pupil's instruction. There appears to be a fallacy here. If good habits only are permitted, nothing can be learned or executed. The novice must inevitably begin with bad habits: if he did not, he would not be a beginner, and would not require to be taught. He begins with bad habits, and goes on slowly and progressively improving them, until at last he acquires good habits, or habits as nearly good as are compatible with his own capacity and his master's skill. If he and his instructor

* See p. 333, *ante*.